DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 4 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al (US 6,189,771) in view of Mei (US 6,680,128), and further in view of the collective teachings of Kodas (US 6,951,666) and Kang et al (US 5,837,119).

In regards to claim 4, Maeda discloses a method for soldering a first electrode 18 with a solder portion19 to a second electrode 12 by melting under heat the solder portion of the first electrode (column 4 lines 38-51), as observed in the sequences

depicted in figures 4A-4B, where electrode 18 (shown but not labeled in figure 4; shown and labeled in figure 3 which is an embodiment of figure 4) and electrode 12 are the first and second electrode, respectively.

Maeda discloses (a) coating a metal (solder) paste 5 on at least one of the solder portion 19 of the first electrode, the soldering paste formed of resin (flux) component (column 4 lines 1-8). Maeda discloses that the solder portion is melted and the solder portion wets the metal paste (column 4 lines 22-36). Since Maeda discloses "wetting" of the solder paste, it is the Examiner's position that the solder portion wets and spreads along the surface of the solder paste when the solder portion is fluidized.

Maeda discloses (b) positioning the first electrode directly above the second electrode so the metal paste 5 placed between the solder portion (on the solder ball 19) of the first electrode and the second electrode (metal paste 5, figures 4A-4B).

Maeda discloses (c) letting solder come in contact with the second electrode by melting the solder under heat and wetting and spreading the molten solder along the surface of the metal powder included in the solder paste by guiding/directing the molten solder (column 3 lines 22-35 and column 5, lines 13-65).

Maeda discloses (d) solidifying the molten solder after letting molten solder come in contact with the first electrode and the second electrode, thereby forming a soldered portion which connects the first and second electrode (column 4 lines 21-36).

Maeda teaches that the metal paste is made by mixing a metal and flux (column 4, lines 1-4). However, Maeda fails to teach that the paste includes a liquid basis formed of resin component, an activator removing oxide film produced on surfaces of the solder

portion, a metal powder having a core metal and a surface metal to cover surfaces of the core metal and that core metal includes tin or a tin-based alloy and the surface metal includes silver.

However, Mei teaches solder pastes where a particular solder composition is most preferably a metal alloy of ***tin*** and zinc (core metal) coated with a material preferably selected from copper, ***silver***, palladium, tin, or gold (Column 2, lines 19-24). Mei also teaches that the coated solder composition used in the solder paste is also suitable for being combined with a flux containing a rosin, derivatives of a rosin such as a dimerized resin, an activator, and a solvent (Column 4, lines 40-49), thus the paste would have a sense of liquidity (liquid basis).

In view of Mei's teachings, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine, with Maeda's soldering method that solders together two electrodes by a soldering bump through the use of a soldering paste, a particular soldering paste that contains a core and surface metal, since using a paste that contains a core and surface metal would allow for lower melting points, longer shelf life, and better effective wettability properties (Mei, Column 3, lines 5-10).

Since Maeda teaches a similar soldering method as the current invention (as stated above) and the solder paste of Maeda as modified by Mei is not structurally indistinguishable from the solder paste of the current invention, it would necessarily flow that the surface of the core metal is exposed at a portion of the metal powder which is not in contact with the molten solder while the surface metal is taken into the core metal by dissolution. Even though a portion of the surface metal powder may not be in

contact with the molten solder, the surface metal powder would still be heated and melted when the components are placed in the reflow furnace.

Maeda does not specifically disclose the shape of the metal powder. Mei discloses that the solder powder may be spherical or amorphous (column 3 lines 55-63). This would indicate that Mei is open to the powder being different shapes, including flake-like. While Mei does not *specifically* disclose using a metal powder with a flake-like shape, Kodas teaches the use of metal powders that have a flaky form with very large aspect ratios (column 4, lines 60-66) to form conductive features (column 35, lines 1-18). Where according to Kang, soldering or electrically conductive pastes (column 2, lines 20-25) with metal powders in the flaky form because of their higher aspect ratios are more desirable than metal powder in the regular spherical form because flaky powders provide for better electrical conduction because of their larger aspect ratios, i.e. length of the flake is larger than the width of the flake (Kang, column 5, lines 35-40). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Maeda in view of Mei to use flake-like metal powders since their higher aspect ratios allow for better electrical conduction, as taught by the collective teachings of Kodas and Kang.

Maeda does not specifically disclose the amount of metal powder in the solder paste. Mei discloses that the soldering paste *typically* will be formed by combining the flux to form a paste comprising *about* 50 vol% solder to 50 vol% flux. This is not within the range of 1-20 vol% as disclosed by the claim; however, Mei discloses that this is *typically* the amount used to form the paste which indicates that other amounts are also

possible. Mei also states that the concentration of coated metal powder in the solder paste can affect various properties of solder paste such as, for example, viscosity, ease of deposition, slumping, tack retention and shelf life and also that the concentration of solder powder in the paste also affects the thickness of the solder remaining after the paste is re-flowed (column 4 lines 56-66). This would indicate that it would have been obvious to one of ordinary skill in the art at the time of the invention to determine a suitable amount of powder to flux within the solder paste to create a solder paste with properties desired for the bonding process since it has been held that discovering an optimum value or a result effective variable involves only routine skill in the art. *In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).*

Maeda with Mei, Kang and Koda do not specifically disclose that the soldered portion is formed by the solder portion and most of the metal powder included in the soldering paste for coating in step (a). However, since the soldered portion is formed from the solder portion and the metal powder included in the soldering paste for coating in step (a) and since the combined prior art discloses a similar bonding process as the claimed invention, it is the Examiner's position that the soldered portion is uniformly formed by the solder portion and most of the metal powder included in the soldering paste for coating in step (a).

Regarding claim 10, Maeda discloses that the first electrode 18 and the second electrode 12 protrude from the respective substrates.

4. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al (US 6,189,771) in view of Mei (US 6,680,128), and further in view of the collective teachings of Kodas (US 6,951,666) and Kang et al (US 5,837,119), as applied to claim 4 above, and further in view of Taguchi et al. (2003/0121564).

Regarding claim 8, Maeda with Mei disclose that the activator may be an aromatic acid (column 4 line 32-48), but not specific to the type of aromatic acid. However, Taguchi discloses using dihydroxybenzoic acid (an aromatic acid) in a solder flux (paragraph 0055). To one skilled in the art at the time of the invention it would have been obvious to use dihydroxybenzoic acid in the flux of Mei because Taguchi states that it improves the spread ability of the solder (paragraph 0055).

5. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al (US 6,189,771) in view of Mei (US 6,680,128), and further in view of the collective teachings of Kodas (US 6,951,666) and Kang et al (US 5,837,119), as applied to claim 4 above, and further in view of Kawabata et al. (JP2003-264259).

Regarding claim 9, Maeda discloses that the solder portion of the first electrode includes a solder portion and the second electrode includes a protruding portion corresponding to the solder portion. Maeda does not specifically disclose that the first electrode includes a plurality of solder portions and a second electrode including a plurality of protruding portions corresponding to the plurality of solder portions.

However, Kawabata discloses a semiconductor device with first electrode 3A including a plurality of solder portions 10, 11 and second electrode 2A including a

plurality of protruding portions corresponding to the plurality of solder portions (figure 1 paragraphs 0037). To one skilled in the art at the time of the invention it would have been obvious to have the first electrode include a plurality of solder portions a second electrodes including a plurality of protruding portions corresponding to the plurality of solder portions because it is well known in the art to have plurality of solder portions and corresponding electrodes when forming semiconductor devices.

Maeda also does not specifically disclose that at least one of the solder portions of the first electrode and at least one of the protruding portions of the second electrode are contacted, while at least one of the solder portions is not in contact with a corresponding one of the protruding portions.

However, Kawabata discloses using smaller balls/solder portions 11 on the outer corners and the central part of the semiconductor device when bonding where these smaller solder balls/solder portions do not contact the second electrode when the bigger solder balls/solder portions contact the second electrode (figure 1). To one skilled in the art at the time of the invention it would have been obvious to have the smaller solder balls/ solder portions on the outer and central part of the semiconductor device because Kawabata discloses that it allows for easy checking to ensure that the solder has completely melted without having to perform an x-ray on the interior portion of the semiconductor device (paragraphs 0011-0018).

Response to Arguments

6. Applicant's arguments filed 4/29/2011 have been fully considered but they are not persuasive.

7. The Applicant argues that one of ordinary skill in the art would not have been motivated to combine Kodas/Kang with Mei because the requirements and properties of the metal powder are different between Mei and Kodas/Kang. The Applicant argues that the flake like metal powder of Kodas does not melt.

The Examiner disagrees. The Examiner was only using Kodas/Kang as secondary references to show that it is known to use metal powder of different aspect ratios (flake-like powder) in solder material. The Examiner was not looking to Kodas/Kang for the method of soldering. The Examiner maintains the rejection that it would have been obvious to use flake-like powder of Kodas/Kang in the method of Mei.

According to Kang, soldering or electrically conductive pastes (column 2, lines 20-25) with metal powders in the flaky form because of their higher aspect ratios are more desirable than metal powder in the regular spherical form because flaky powders provide for better electrical conduction because of their larger aspect ratios, i.e. length of the flake is larger than the width of the flake (Kang, column 5, lines 35-40). Since the Prior Art teaches the motivation and the Applicant has not provided evidence to prove otherwise, the Examiner maintains that the flaky metal powder provides a better electrical conduction in the solder paste.

8. The Applicant argues that claimed range of metal powder (1-20wt%) would not have been obvious. The Applicant argues that one of ordinary skill in the art would not have been motivated to reduce the amount of solder powder from 50 wt% (Mei) to the claimed 1-20 wt% which is less than half of 50 wt%. The Applicant argues that if the amount of solder powder in Mei were reduced to 20 wt% or less, the electrical conductivity of Mei's solder paste would be poor and such a solder paste would not function as intended.

The Examiner disagrees. Mei discloses that *typically* solder is in the range of *about* 50 wt% (as stated in the rejection above). The Applicant has not provided any evidence or support that when Mei is reduced to 20 wt% or less that the electrical conductive would be poor and would not function as intended.

The Examiner maintains their position that while Mei discloses that this is *typically* the amount used (50 wt%) to form the paste, the term *typically* indicates that other amounts are also possible. Mei also states that the concentration of coated metal powder in the solder paste can affect various properties of solder paste such as, for example, viscosity, ease of deposition, slumping, tack retention and shelf life and also that the concentration of solder powder in the paste also affects the thickness of the solder remaining after the paste is re-flowed (column 4 lines 56-66). This would indicate that it would have been obvious to one of ordinary skill in the art at the time of the invention to determine a suitable amount of powder to flux within the solder paste to create a solder paste with properties desired for the bonding process since it has been

held that discovering an optimum value or a result effective variable involves only routine skill in the art. *In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).*

Conclusion

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ERIN B. SAAD whose telephone number is (571)270-3634. The examiner can normally be reached on Monday through Thursday from 8am-5pm Eastern time.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jessica Ward can be reached on (571) 272-1223. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/E. S./
Examiner, Art Unit 1735
5/18/2011

/JESSICA L. WARD/
Supervisory Patent Examiner, Art Unit 1735